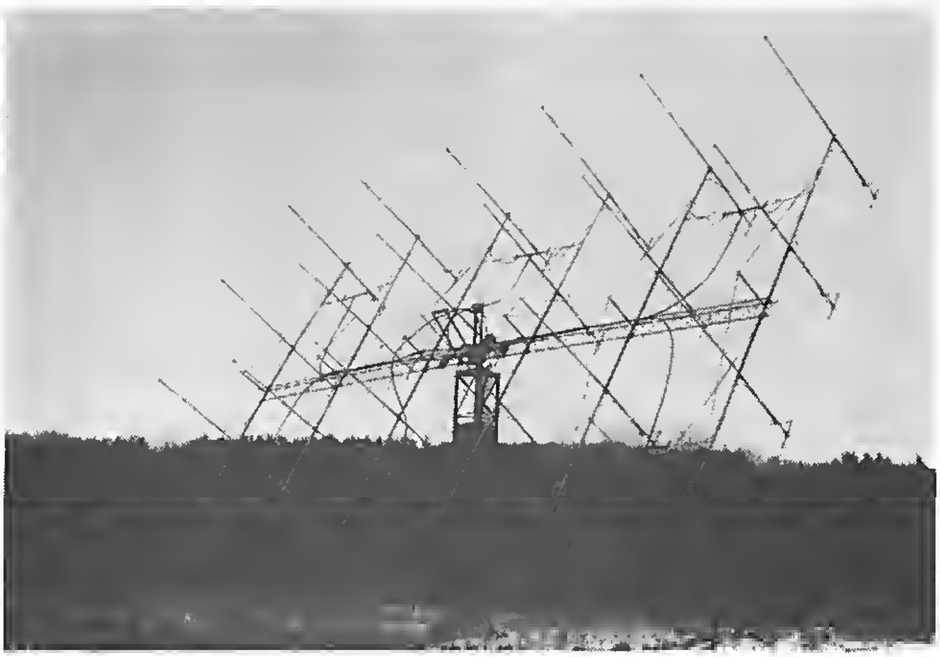
THE K1WHS ANTENNA



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AS49-32

THE "MAINE MONSTER"

by Dave Olean, K1WHS

Plans for a new 144MHz EME array began in 1978. After working all states and continents on 144MHz, a new goal was definitely in order. Having no intentions of abandoning two meters, the only choice remaining was to build a new and much larger array capable of truly outstanding results.

The basic goal was to construct a system capable of communicating with single yagi stations with good reliability. The choice of antennas for such an array is a varied one today. Many yagis are now capable of outstanding performance when compared with designs available ten years ago. The yagi chosen for my new array was the Cushcraft 214B yagi. It develops gain essentially similar to the F9FT 16 element yagi on a 15 foot boom. I found that I could get more gain per unit wind loading than any other yagi now commercially available. This is of paramount importance when contemplating wind areas of 75 square feet!

Experience had shown that it was possible for yagi systems consisting of four F9FT yagis to communicate with similar systems. Sixteen yagis should allow communication with a single like yagi. I "threw in" another 8 yagis (or 1.8dB) for good measure to allow consistent communication with single yagis. The 24 yagis planned provide enough gain to contact a 10dBd antenna system. That requirement is easily met by a 1.7λ yagi and 1dB of feedline loss. Transmitter power should be 500 watts at the antenna.

The array was planned to be 30 feet high by 56 feet across as measured from boom to boom. An array of this size has almost 500 feet of coaxial

cable in the phasing system. A low loss coaxial cable system was built utilizing 24 sections of "times" wire Ip-8 (similar to FM-8) each 12 feet long. Each cable ran to an aluminum square power divider located at the center of each four-bay array. There are six four way power dividers in the array. A single six-way power divider is located at the center of the EME array. Thirty feet of coax is required between each four-way and the six-way power divider. If RG-8/U type coax was employed for that span, almost 1.0dB of loss would be encountered.

I chose 3/4" fused disc CATV coax with a loss of .18dB per each 30 foot span. The CATV hardline required a 75 ohm output from each four way divider and six 75 ohm inputs on the six way power divider. The six way divider has a 50 ohm output that feeds into a 275 foot length of 3 inch air dielectric heliax that runs into the shack. Total loss between each driven element and the transmitter is .8dB.

The overall view of the antenna is shown in Figure #1. The middle upper and lower four bay array are located physically close to the six way power divider in the center of the array. Rather than coil up the 30 feet of 3/4" hardline on the array, I cut out exactly two wavelengths from each coax length feeding the central four bay systems. No evidence of "beam steering" is noticeable. The pattern looks symmetrical.

The rotating system is a simple AZ-EL system. Elevation is controlled by a Sears Super Winch very similar to that devised by W4DFK and K2RTH. Azimuth rotation is accomplished by a 220 volt AC motor gear box combination that drives a second gear box with an extremely high torque rating. The big gear box is a military surplus unit weighing 200 lbs. and sporting a 4200 inch/pound rating for turning torque. It turns the 650 lb. antenna with ease at .25 RPM with almost noiseless oper-

ation. The azimuth rotor is built inside a small plywood "house" located 2/3 up the 20 foot support tower. The wooden house sports adequate room for a 12 volt battery and relays to power the Super Winch. Pre-amps and associated circuitry may go in the house as time permits. A battery charger trickle charges the battery periodically.

Gear motors are available at many surplus houses. The 200 lb. gearbox was found in a Denver, Colorado junkyard.

Array performance has been exactly as planned. Gain is estimated at around 26dBd. The -3dB beamwidth is 9^{0} x 5.9^{0}. The first side lobe is 13-14dB down. Contact with single yagi stations is very easy. Stations running single yagis have been heard running up to 1½ S-units out of the noise on peaks on the horizon. Since the single yagi main lobe is very broad, signals are available for over one hour after moonrise!! This is quite different from what was encountered in years past where horizon shot signals would peak and fade in ten minutes or so! Echo testing on CW is a good way to monitor performance. Returns are audible during perigee periods with 5-10 watts of RF output. During enhanced periods, I am sure detectable echoes will be heard down to the 1½ watt level. Such performance is enough to prop up the eyelids of any two meter Dx-man.

Figure #2

Detail of the main support tower. Tower height is twenty feet. The triangular tower is 42 inches on a side and is self supporting in over five yards of concrete.

The horizontal cross boom is heights tower of aluminum construction, 14 inch sides and heavy duty wall thickness. Overall length is 57 feet.

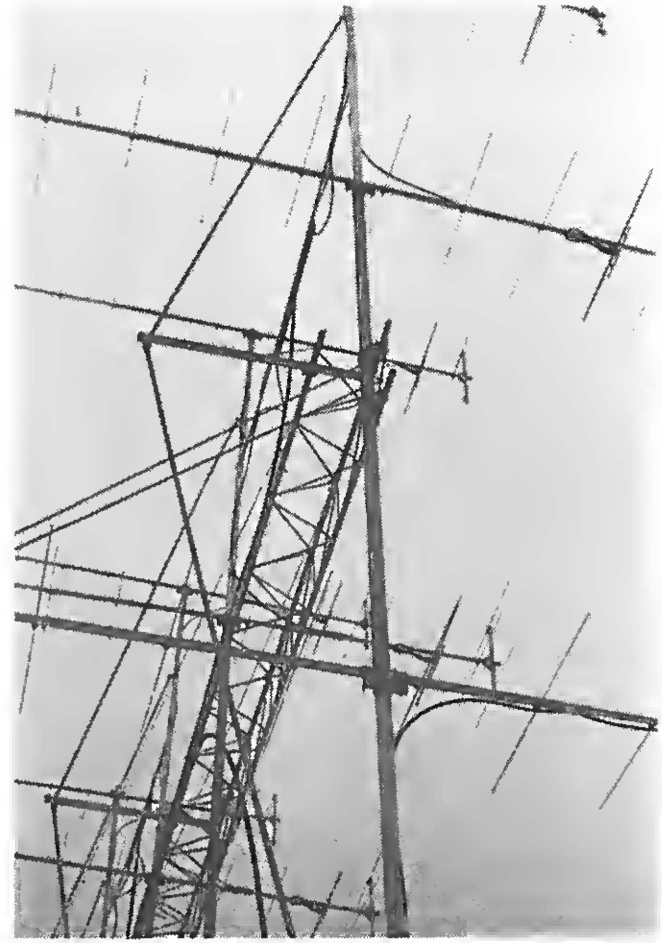

Figure #3

Vertical support mast consists of a ten foot section of 2-1/8" O.D. steel EMT conduit with 2" and 1-7/8" x .058" wall aluminum tubing for a total height of thirty feet. Two pieces of 12 ft. long 3/4" aluminum tubing act as support brazing to maintain array shape at high elevation angles.

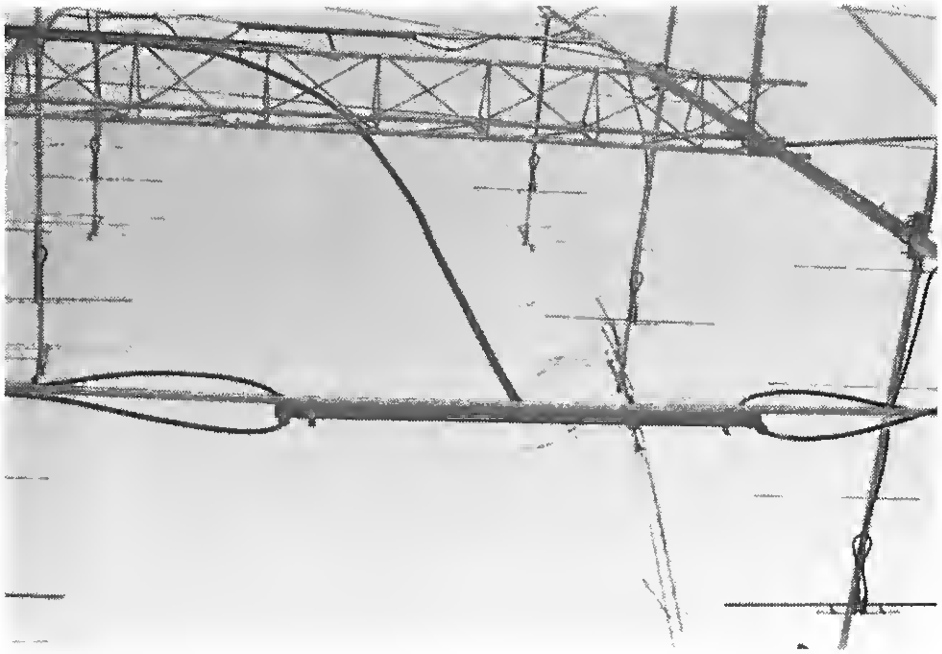

Figure #4

Four way power divider with 75 ohm output port and four RG-8/U style coax feeding each 214B yagi. Each power divider is supported by a section of 3/4" aluminum tubing.

Figure #5

Details of elevation system employed. Sears Super Winch is mounted on a fixed plate with a four way pulley attached to the hinged tower cross boom. The four way speed reduction is a necessity due to the size and narrow beamwidth of the array. "H" plane = 9°. "E" plane = 5.9°.

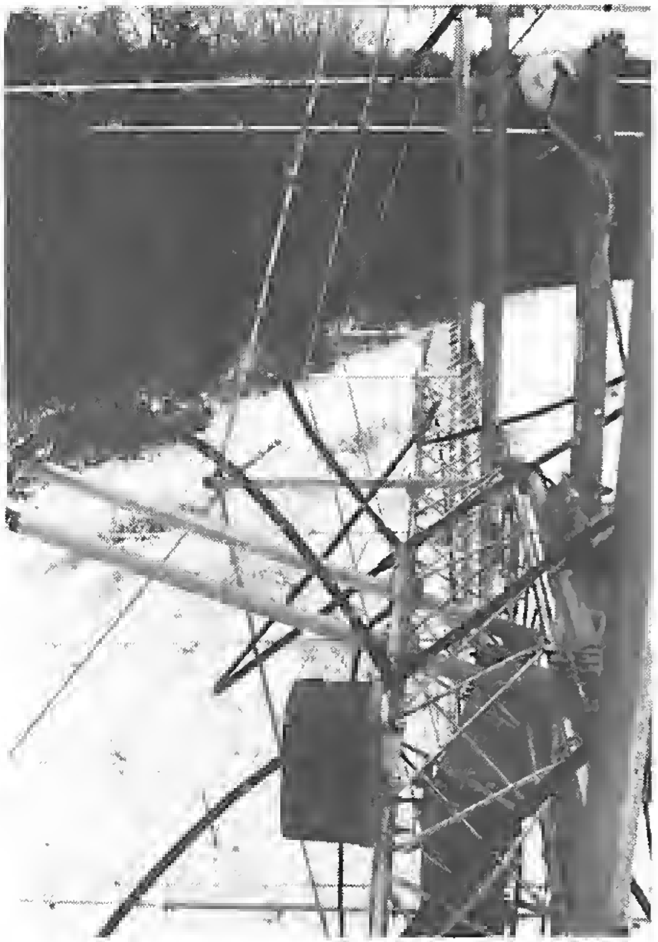

Figure #6

The cross boom is shown with a closer look at the elevation drive system. The large box in the foreground houses the elevation drive system. Aircraft cable and turnbuckles take the "sag" out of the aluminum tower cross boom. It is possible to walk out on the cross boom to make slight adjustments.

Figure #7

Close up of the tower base. The coax shown is the main feeder of 3 inch air heliax. A large cast aluminum housing protects the azimuth relay system and terminal blocks for all tower wiring. Tower legs are 5/16" thick by 3".

Figure #8

The triangular top section of the tower consists of a 3/8" steel plate with a simple bearing surface attached to guide the main support mast. The support mast is a 5 inch diameter ¼" wall steel pipe. A steel shim was required to properly align the top bearing.

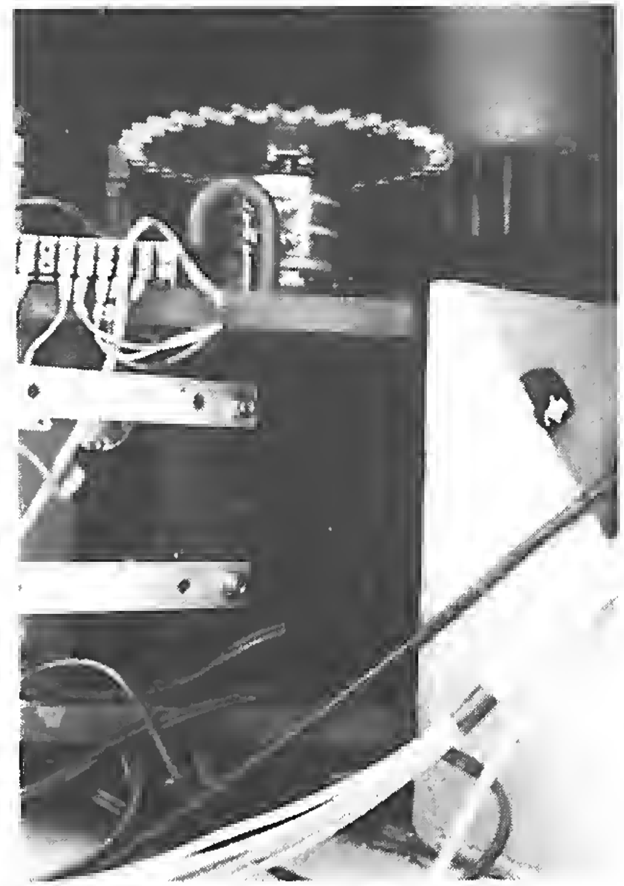

Figure #9

The azimuth rotor is shown in this view. The 220 volt gear head motor is on the left. An 1-5/8" shaft coupling connects the 9.5 RPM gear-head motor to the big gearbox and is attached to the five inch main mast by three 3/4" steel bolts. Azimuth bearings are read out on a selsyn display in the operating room. A 6 volt 60Hz selsyn is shown directly coupled to the main gear through a homemade "plexiglas" gear. Note the 225 watt soldering iron stuck under the gearbox for fast get-aways in the -20^{0}F Maine winters.

Figure #10

Head end of 3" heliax cable. A short section of RG-8 provides the flexible portion around the rotator. One mounting plate and a portion of the elevation hinge is visible at upper left. The rectangular box houses the elevation selsyn.

Figure #11

To protect the array in high winds and ice storms, (both common in Maine), auxiliary towers are provided to support and lock down the extremities of the 56 foot aluminum cross boom. Tower shown is 20 feet of Rohn 25 with a homemade hinged base.

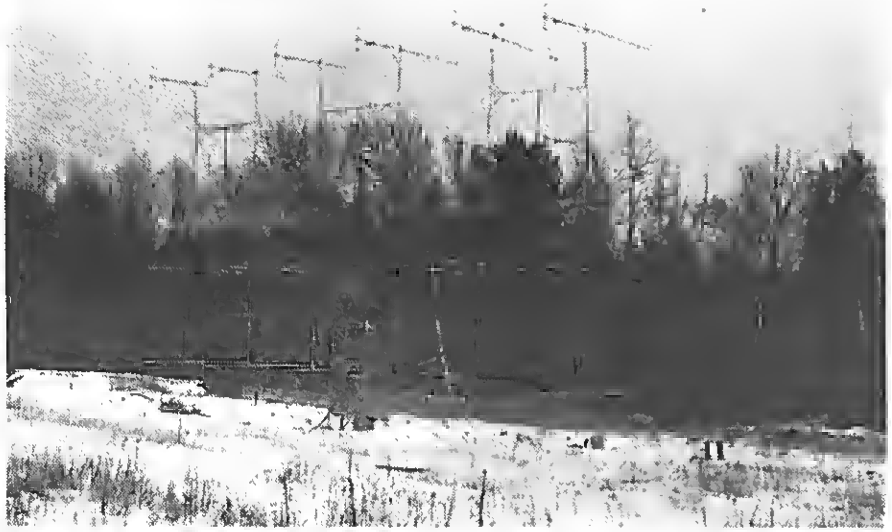

Figure #12

Antenna is shown in the "stored" position. Note the tie downs at the base of each vertical support mast. These tie downs firmly hold the mast and clip on with "dog leash" type fasteners. The whole array hardly wiggles in 75 mph winds.

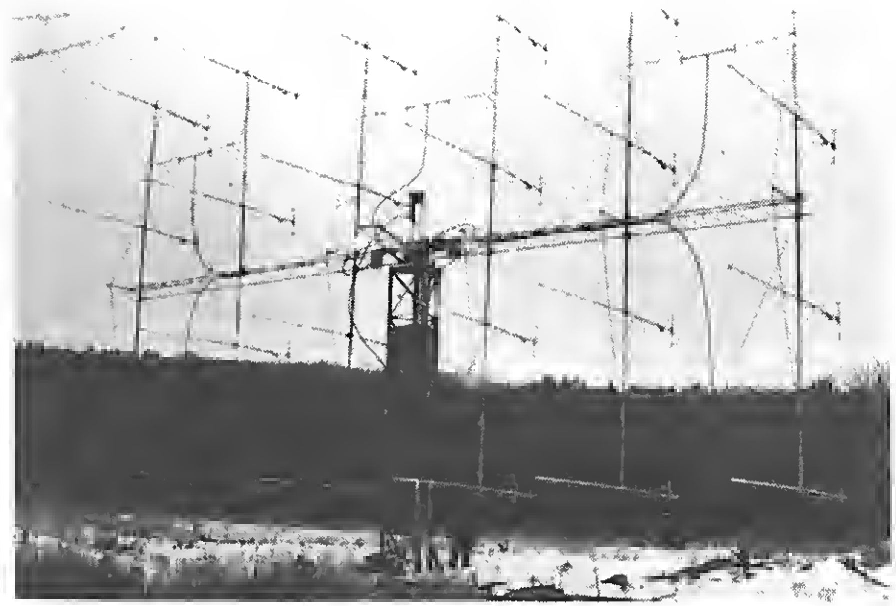

Figure #13

The person standing at the tower base is K1WHS. The scale of the antenna may be easily seen. K1WHS is six feet tall. Note that the center-lower 4-way power divider is offset forward one foot or so in order to clear the tower at 0^{o} elevation angles. The elevation hinge plates and hinge are plainly visible. Width is approximately 80 inches. Hinge material is 2" O.D. drawn steel tubing with an ¼" wall. Water pipe is not satisfactory on an array of this size.